CENTER ROUTING SLIP

FROM	DATE
Director, NPIC	4 Sept 1970

TO		INITIALS	DATE	REMARKS
DIRECTOR				
DEP/DIRECTOR				
EXEC/DIRECTOR				
SPECIAL ASST				
ASST TO DIR				
HISTORIAN				
	1	GWF	4 Sept.	
CH/PPBS	2	[redacted]		9/10
DEP CH/PPBS				
EXO/PPBS				
				Fil, A0360
CH/SS				
DEP CH/SS				
SC & P				
RECORDS MGT				
PERSONNEL				
LOGISTICS				
TRAINING				
SECURITY				
FINANCE				
CH/IEG				
DEP CH/IEG				
EXO/IEG				
CH/PSG				
DEP CH PSG				
EXO PSG				
CH/TSG				
DEP CH/TSG				
EXO/TSG				
DIR/IAS/DDI				
CH/DIAXX-4				
CH/DIAAP-9				
CH/SPAD				

STAT
STAT

IP FORM 30 (7 70) OBSOLETE PREVIOUS EDITIONS

L. —
JWG —
AGL.

DISPOSITION FORM

For use of this form, see AR 340-15; the proponent agency is The Adjutant General's Office.

REFERENCE OR OFFICE SYMBOL	SUBJECT
AMSEL-HL-NV-VIS	Trip Report - AFCRL and Puerto Rico - [redacted] 6-23 January 1970

25X1

TO See Distribution FROM [redacted] DATE 11 Feb 70 CMT 1 STAT

[redacted] pac/278 STAT

1. The responsibilities of the Photographic Interpretation Research Division (PIRD), U. S. Army Cold Regions Research and Engineering Laboratory (USACRREL) on the Barrier/Counterbarrier program include a photo interpretation study or environmental analysis on a regional basis of the island of Puerto Rico, the monitoring of the tunnel construction site with various types of aerial photography to detect elements of change within the landscape components, and the testing and evaluation of various airborne sensors as they pertain to both specific target detection problems and to terrain evaluation studies.

2. This field trip was made to take aerial photography that would establish a zero time data base for the tunnel detection task and to contact various agencies engaged in research and application throughout the island. Puerto Rico has been studied, mapped and photographed for many years and much of this information and experience will be of use to our work. In turn, some of the information and data from our photo analysis and remote sensing studies might be of benefit to others. Mr. [redacted] (Tropical Terrain Research Detachment - Waterways Experiment Station) and [redacted] (formerly with the Department of Public Works, but now a private consulting geologist) were instrumental in providing us with information about research activities and problems on the island, as well as with contacts with various offices of the Commonwealth and Federal structures. A list of offices and individuals visited is provided. At these meetings, I told them that we were doing a regional environmental analysis via aerial photography and would also be evaluating various airborne sensors over different areas of the island. I stated that we were concerned with their interests and activities, since much of their experience and information could be of direct aid to us; secondly, we wished to avoid needless repetitions in our efforts; and, lastly, some of what we will do, either as derived information, ground measurements or simply a photo, might be of use to them. The cost of taking aircraft, sensor systems and people to Puerto Rico is high - the added cost of a few more miles of flight line or turning the cameras and scanners on for a few feet of film are rather insignificant. Many of their areas of interest are so located that we must fly near or over them en route to our own study area. More important, their interests and activities overlap many of those of Barrier/Counterbarrier and, thus, there is much to be gained for all concerned.

STAT STAT

DA FORM 2496 REPLACES DD FORM 96, EXISTING SUPPLIES OF WHICH WILL BE ISSUED AND USED UNTIL 1 FEB 63 UNLESS SOONER EXHAUSTED.

3. Within the U. S. Geological Survey, [redacted] STAT reviewed their interests and activities and [redacted] STAT offered to provide any information and field data they might have on geology, etc. Among other things, they have a strip or area of interest that runs from about the mid-point of the north coast to the southwest coast. NASA flew their airborne systems over it (1968) and this collection of imagery is in the Survey Office in San Juan. It contains Ektachrome Infrared and Ektachrome-MS (both in the nine-inch format); panchromatic photography with the three primary filters - 47B, 58 and 25A - (five-inch format); black-and-white infrared with an 89B filter, infrared thermal imagery (8-14 micra band) and side-looking radar. The aerial photography (at different scales) is of excellent quality and might prove useful, since some of the Barrier/Counterbarrier sites are located within the U. S. G. S. flight strip. Some of the U. S. G. S. sites of interest covered by this flight line include an area of near-surface oxidative ores, an exposed mixture of metaphoric rocks, an area of adjacent serpentinites and volcanics and a variety of caves. The oxidative ores might have enough thermal contrast for an infrared thermal scanner to depict them - and to provide, thereby, a rather unusual target for evaluating such sensors as aids in general terrain analysis or in mineral prospecting or resource inventory tasks. This also applies to the mixed rock areas, although some form of aerial photography might prove of more value in separating and identifying such features. The locations of these various areas, as well as the Barrier/Counterbarrier sites are shown in Figures 1 and 2.

4. The caves were a subject of discussion in many of the offices visited, for they are of interest to the geologist per se and to those working with water resources and pollution problems. General cave regions and some specific caverns are shown in Figures 2 and 3. The Camuy caverns and a few others are fairly well known, but the system is more extensive than that - extensive and intricate beyond current knowledge, for that matter. Most of the caves occur in the limestone regions and have come about by solublization processes. Some of the caverns are dry and others are wet, for they are intimately associated with the drainage system, as evidenced by numerous sinkholes with water at the bottom and the disappearance and

reappearance of many streams. According to reports, some of the caverns are extensive - being better described in tens of feet, rather than in units.

5. In view of the interest in caves during the Cuban missile crises and the liklihood of such interest arising again in other parts of the world, it would be appropriate to study the caves in conjunction with the man-made tunnel. Although some of the caves were studied by the TTRD of WES, a good bit of work remains to be done in understanding cave (and tunnel) dynamics - how they breathe, the lag behind changes in atmospheric pressure, speed of exchange, temperature lag (if any), gas and particulate characteristics, etc. Also, any of the airborne sensing systems used on the project should be evaluated for detection purposes. STAT [redacted] and his staff (WES) and [redacted] (USGS) have had STAT the most experience in examining some of the caves and have offered to help where possible on any such project. A word of caution is in order - for a fungal infection (histoplasmosis) is associated with bat dung or guano and some of the caves have large bat colonies. WES personnel and USGS personnel were ill with this disease after their cave work. (There may be ways to avoid this problem, or at least to lessen the risk to an acceptable level.) The caves may show enough variety (i.e., some with bats, swallows or empty) to allow for their use as test sites for airborne atmospheric analysis (gases, large molecules, particulates, etc.) and such studies should be done -- ground based at first, but eventually worked into "bread board" type airborne experiments. As a first step towards measuring some cave parameters - and, if circumstances permit, we intend to install some instruments (hygrothermograph and microbarograph) both inside and outside a cave during a future field trip. If and when the infrared scanners are used in Puerto Rico, some of the caves will be included in one of the flight lines.

6. [redacted] of the U. S. Geological Survey is conducting a STAT four year program in mapping the mineral resources of Puerto Rico. Towards this end, he will be doing geochemical analyses of streams. He is also interested in the airborne detection of mercury vapor, a technique currently used for mineral prospecting. It is quite possible

that during the construction of a tunnel, spoil material could enter a drainage system and alter the chemical characteristics of the water to a significant extent. Thus, the results of his experiments, both in geochemical analysis and airborne trace vapor detection, are of interest to the Barrier/Counterbarrier project. It is equally true that results from the Barrier/Counterbarrier experiments would be of interest to the U.S.G.S.

7. At the Water Resources Division of the U. S. Geological Survey, [redacted] reviewed some of their STAT
past work and their present field activities. Water shortages exist in some areas during part of the year and water pollution is an increasing problem, as it is elsewhere. They are mapping the drainage system but, as indicated earlier, the disappearing streams and the subsurface network in the limestone areas are not all charted. Some of the sinkholes offer tempting sites for waste disposal - which could lead to severe water pollution - but not on a predictable basis, since the subsurface pathways are but little known. They are also interested in caves and sinkholes and stated that it would be of help to them if, during our photo analysis, we would mark sinkholes - particularly sinkholes with water at the bottom. This we will try to do. Based on their observations, they think it possible for fresh water to be up-welling at certain spots along the north coasts. Nighttime infrared thermal imagery in the 8-14 micra region might well detect these locations and on one of the future missions such a flight should be tried.

8. [redacted] took me through some of the laboratories STAT
and offices of the Department of Public Works, Commonwealth of Puerto Rico, where I was briefed on their activities. [redacted] STAT
[redacted] is the Secretary of this Department. Under him STAT
are the areas of Administration, Traffic, Construction, Flood Control and Beach Conditions, and Natural Resources - each headed by an Assistant Secretary. Under these areas are Bureaus and under them are Divisions. Within the Bureau of Materials there are considerable data and expertise (laboratory and field) on Puerto Rican soils which are available and could be of use to the Barrier/Counterbarrier project. [redacted] a Research Engineer in STAT

the Research Division, is responsible for developing a computer program that will incorporate their soil data. In addition, he is their authority on pollution problems. The technological development of Puerto Rico has proceeded at such a pace that pollution, in one form or another, has passed beyond the annoyance stage. This pollution involves the soils, water and air and is caused by thermal waste, chemical waste, petroleum refinery waste, sewage - to name but a few of the sources. These sites are to be found throughout the island; some are near Barrier/Counterbarrier work areas (See Figure 2) and would provide excellent test conditions for a variety of airborne sensors - induced fluorescense, laser scanner, thermal scanners, film/filter combinations, atmospheric samplers, etc. Not only are such problems of direct concern to our government (this will be increasingly true) and thus a worthy endeavor on that basis alone, but they need attention simply for the reason that they have not been adequately studied. A careful evaluation of various sensor systems for detection, defining and monitoring purposes has not been done. The resultant data are useful not only to the problem of pollution but to the end goal of gaining insight and understanding into the limitations, reliability, sensitivities, advantages and disadvantages of the systems themselves as they are applied to any specific future problem.

9. The Topographic Mapping and Photogrammetric Division of the Department of Public Works has an extensive program and very good facilities. They recently purchased a Zeiss mapping camera with a Universal lens and an aircraft. These should be operational later this year. In addition to their mapping duties, they have an assigned interest or mission in pollution studies (soils and water), and, thus, are interested in our environmental analysis and remote sensing data. They can cooperate with a government agency and are willing to do so - i.e., they could provide special photography and help in the interpretation. To establish such an arrangement, a letter must go through channels (of the Army in this case) directly to the Secretary of the Department of Public Works.

10. I next visited [redacted] of the Institute of Tropical Forestry, U. S. Department of Agriculture. One of their projects STAT

is devoted to studying the forest environment, to learn how to extend the forest boundaries and to learn the conditions required to establish forested zones within urban areas. They are interested in our photo analysis and will provide any ground data they have that would be of use. They would also like to see any aerial photography or other imagery that becomes available. In previous years, the PIRD cooperated with them in studying radiation damage of vegetation before and after intensive radiation (cesium source) of an area in the rain forest. I talked to [redacted] and [redacted] at the El Verde Research Center in the Loquillo Experimental Forest (both were involved in this work) and aerial photography has not been taken since our last flight in 1966. Recovery of the site is now well along and should be documented (we will try to include this on one of the future photo flights). They are also interested in the use of aerial photography for vegetation mapping and would like to see any results of our studies. They have considerable information and ground data that are available to us.

STAT STAT

11. At the Federal Experiment Station in Mayaquez, I talked to [redacted] Officer-in-Charge. Their research program places emphasis on the development of new crops, improving yields and the study of viral infections. They have several "farms" where they grow a variety of crops - some under controlled conditions - and they can provide us with a good bit of the ground data needed for correlation with remote sensor imagery. They can also establish test growth beds and infect them so that the disease cycle can be monitored via remote sensing techniques. This is a unique opportunity for cooperative efforts on a subject important to DOD, to Barrier/Counterbarrier and to science in general, and it should be developed if such an arrangement is indeed possible. Biological warfare and its indirect ramifications can be of natural origin or man-induced; in either event the techniques of detection, identifying and monitoring are the same. Many past efforts have been limited to trial and error procedures or to a single sensor or species. A cohesive body of knowledge as to cause and effect within the biological parameters and the rationale for the selection of any given sensor has not yet been established. A coordinated

STAT

laboratory, field and remote sensing effort here would be of help in establishing such a framework. One item which his laboratory does not have and which would be of great use on this and other aspects of the Barrier/Counterbarrier project is a spectrophotometer. Perhaps ours could be shipped down if use warrents - or preferably another one purchased and installed at the Barrier/Counterbarrier office in Mayaguez.

12. In the same vein, some thought should be given to the potential use of the CRREL mobile tower truck. This truck can place a 600-pound load 88 feet above the ground or fifty feet above the ground and fifty feet out from the truck. The base can be rotated through 360 degrees. A generator provides 115 volts a.c. to the platform and various cabinets for housing instruments, etc., are incorporated into the truck body. It is ideal for gathering near-ground data, gas samples at different heights, temperature profile, vegetation samples, testing "bread board" remote sensors, etc. It is a big truck (14' 3" clearance needed) and, thus, has some mobility limits even though it has 4-wheel drive. Nevertheless, it is a useful item and if there is sufficient joint need, the truck should be inspected, overhauled (as needed) and shipped to Puerto Rico.

13. In summary, Puerto Rico can provide unusual test and evaluation sites; caves; mangrove swamps with hidden waterways; air, soil and water pollution; radioactive and oxidative ores; controlled crops and crop infection sites, unique hydrological features, etc. --- and all in addition to the rich variety of features that led to its selection in the first place. There are many areas of important and mutual interest where cooperative efforts can and should be developed, for the results of such efforts will benefit their problems, as well as the research goals of Barrier/Counterbarrier and will contribute to the overall capability of the Army in the general fields of remote sensing and environmental analysis.

14. Aerial Photography - Site 1. The sugar cane was cut on the tunnel site by 19 Jan and initial construction began about 22 Jan. Before and after aerial photography was obtained with the Hasselblad system at two different scales. Emulsions flown included

normal color, color infrared, black-and-white infrared, unfiltered panchromatic and panchromatic with the three primary filters (25A, 47B and 58). It is not always possible to know the flight conditions at Mayaguez and the plane would take off from San Juan merely on the hope that Mayaguez weather was good. When it is not, then other targets are flown on the return to base. In this way, a heavily polluted area of San Juan Bay was photographed with color and panchromatic film.

15. AFCL and RADC. On the way to Puerto Rico, we visited with [redacted] group at the Air Force Research Laboratories to review to them the remote sensing aspects of Barrier/Counterbarrier and see if there was any way they could cooperate on some of this work. They have conventional cameras, an infrared thermal scanner and have let a contract to build a quantitative scanner. They also hope to purchase a laser profiling system. They are in the process of modifying an aircraft for their work and will be able to fly some time after April. Dr. [redacted] expressed an interest in the project and hoped that they would be able to participate on some of it. An earlier visit had been made to [redacted] group at Rome Air Development Center for the same purposes. They have excellent capabilities in infrared thermal imaging, photography and radar and their systems are considerably different from those of AFCRL or CRREL. Both of these groups (RADC and AFCRL) have had experience in Puerto Rico and could provide valuable input to Barrier/Counterbarrier. It seems likely that at least some level of cooperative effort will come about for at least one mission.

STAT
STAT
STAT

Next 1 Page(s) In Document Denied

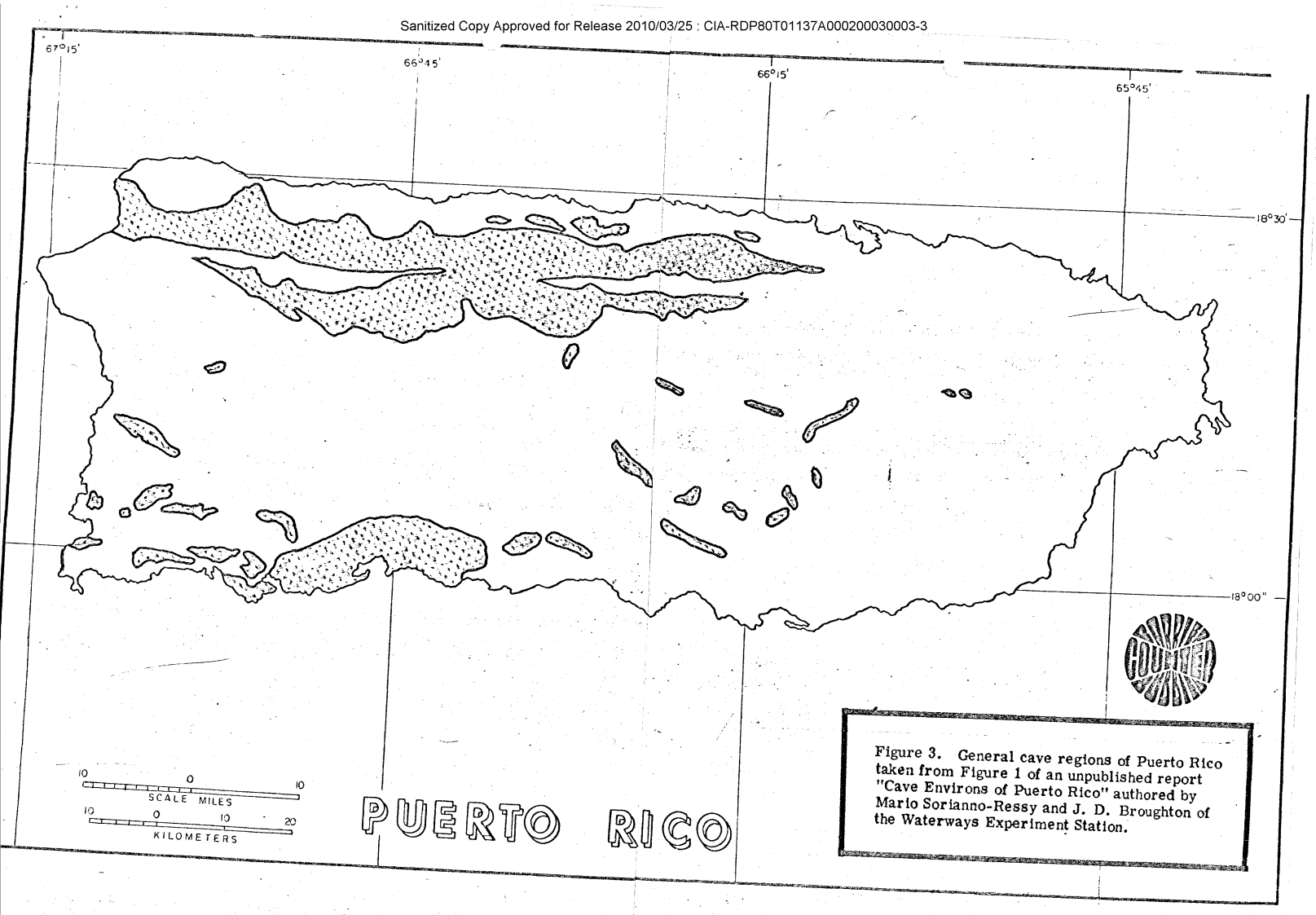

Figure 3. General cave regions of Puerto Rico taken from Figure 1 of an unpublished report "Cave Environs of Puerto Rico" authored by Mario Sorianno-Ressy and J. D. Broughton of the Waterways Experiment Station.

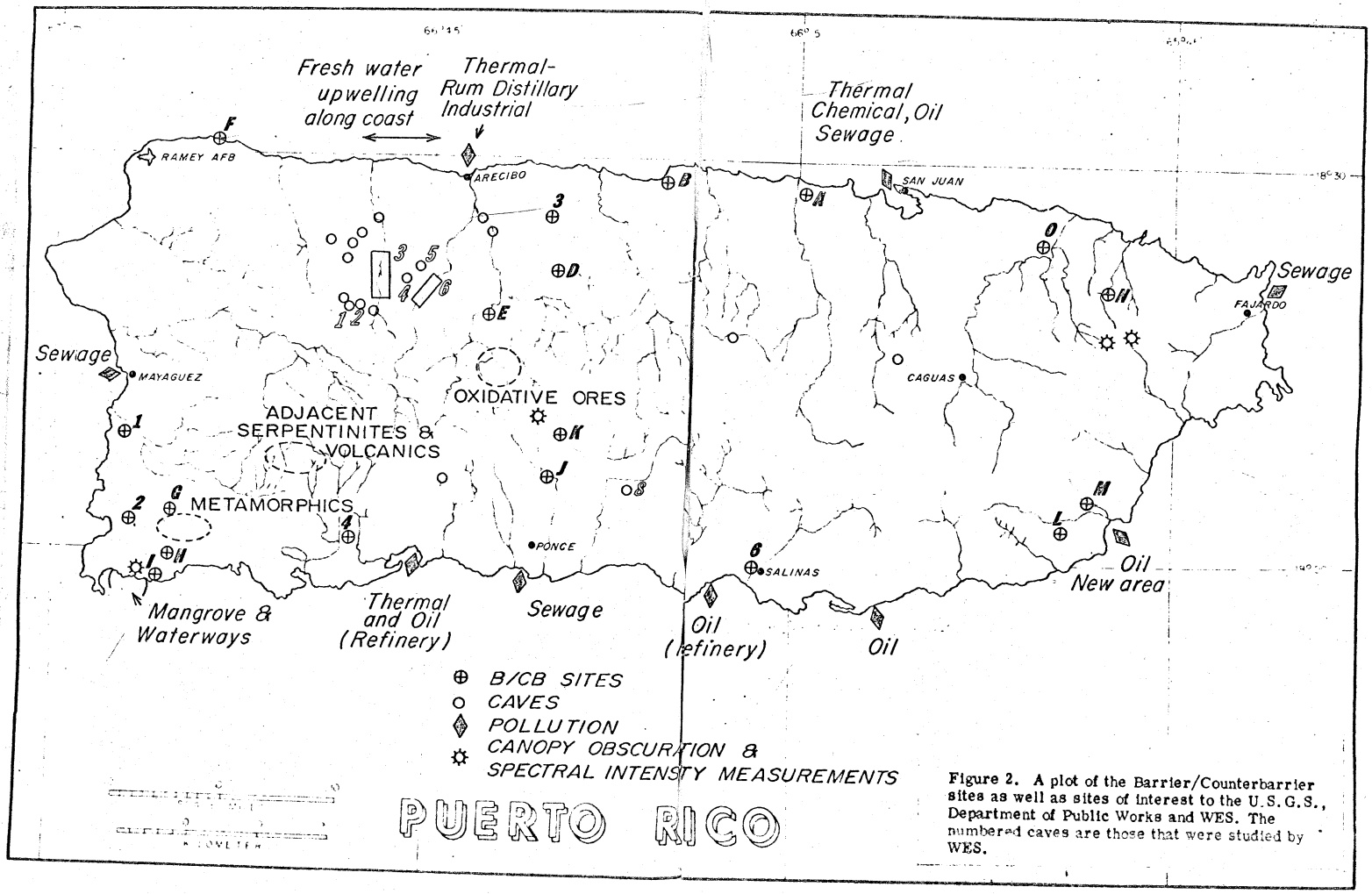

Figure 2. A plot of the Barrier/Counterbarrier sites as well as sites of interest to the U.S.G.S., Department of Public Works and WES. The numbered caves are those that were studied by WES.

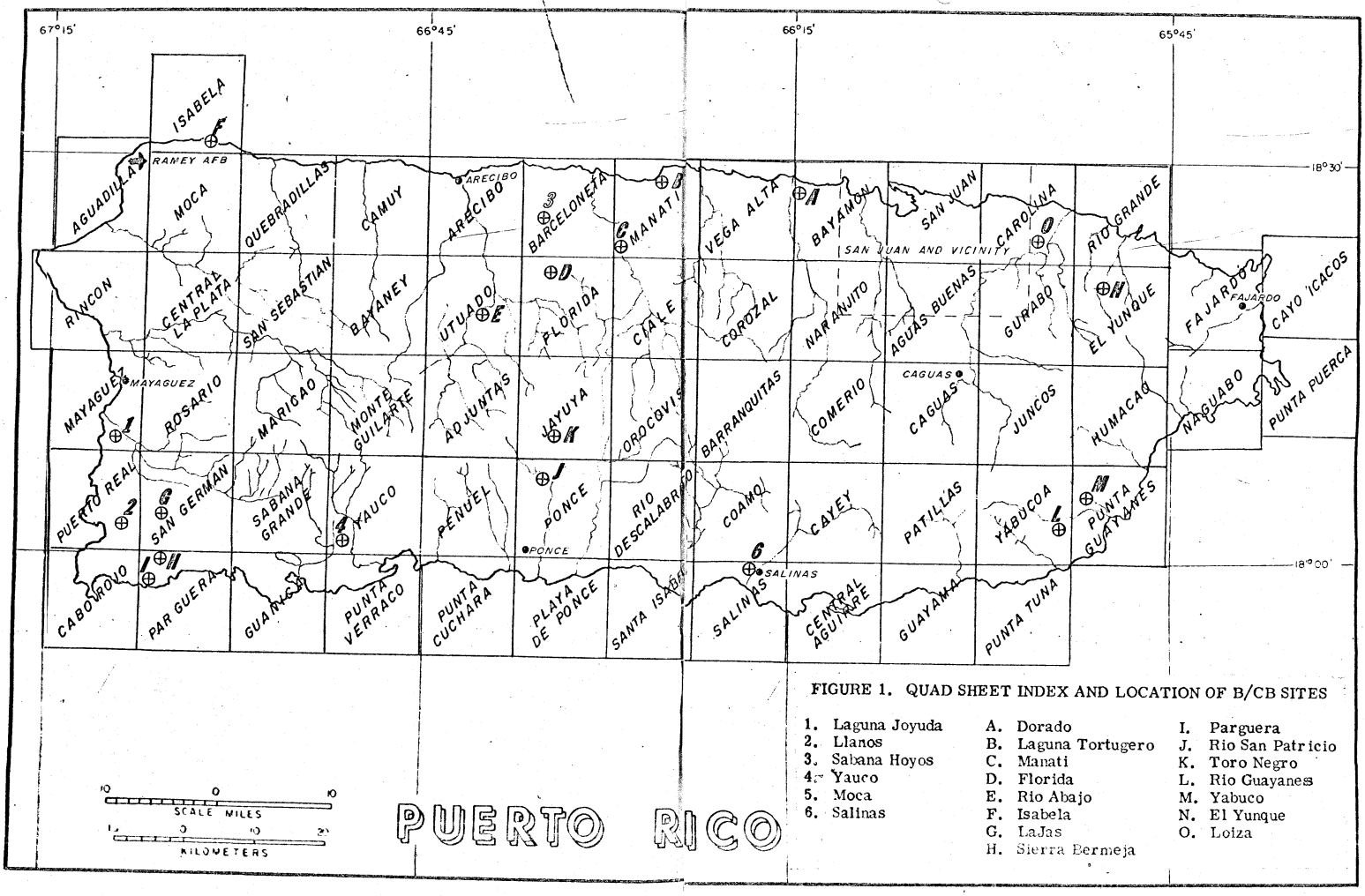

FIGURE 1. QUAD SHEET INDEX AND LOCATION OF B/CB SITES

1. Laguna Joyuda
2. Llanos
3. Sabana Hoyos
4. Yauco
5. Moca
6. Salinas

A. Dorado
B. Laguna Tortugero
C. Manati
D. Florida
E. Rio Abajo
F. Isabela
G. LaJas
H. Sierra Bermeja
I. Parguera
J. Rio San Patricio
K. Toro Negro
L. Rio Guayanes
M. Yabuco
N. El Yunque
O. Loiza